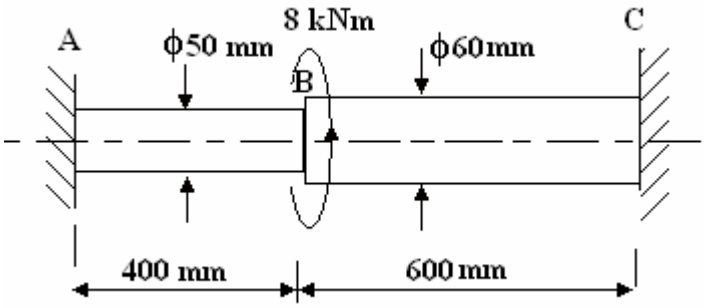
MECHANICAL AND STRUCTURAL ENGINEERING C105
EXAM QUESTIONS 2005 Q4

A solid circular-section stepped shaft ABC is rigidly fixed at both ends and carries 8 kNm torque applied at the change –of-section point B. The diameter of AB is 50 mm and the diameter of BC is 60 mm. determine:

a) the proportion of torque carried by each section.
b) the resulting maximum shear stress in each section of the shaft due to the given loading.



$\frac{T}{J} = \frac{G\theta}{L} = \frac{\tau}{r}$ At B the angle of twist is the same so $\theta = \frac{T_1 L_1}{J_1 G} = \frac{T_2 L_2}{J_2 G}$

$\frac{T_1 L_1}{J_1} = \frac{T_2 L_2}{J_2}$ $\frac{T_1 \text{ x } 0.4 \text{ x } 32}{\pi \text{ x } 0.05^4} = \frac{T_2 \text{ x } 0.6 \text{ x } 32}{\pi \text{ x } 0.06^4}$

$\frac{T_1 \text{ x } 0.4}{0.05^4} = \frac{T_2 \text{ x } 0.6}{0.06^4}$ $\frac{T_1}{T_2} = \frac{0.05^4 \text{ x } 0.6}{0.06^4 \text{ x } 0.4} = 0.723$

$T_1 + T_2 = 8$ kNm $0.723\ T_2 + T_2 = 8$ kNm

$1.723\ T_2 = 8$ kNm

$T_2 = 4.64$ kNm (BC)

$T_1 = 3.36$ kNm (AB)

$\tau = \frac{Tr}{J} = \frac{4640 \text{ x } 0.03 \text{ x } 32}{\pi \text{ x } 0.06^4} = 109 \text{ x } 10^6 \text{ N/m}^2$ (AB)

$\tau = \frac{Tr}{J} = \frac{3360 \text{ x } 0.025 \text{ x } 32}{\pi \text{ x } 0.05^4} = 137 \text{ x } 10^6 \text{ N/m}^2$ (BC)